Organic Discussion Day 25th February, 2016

At previous organic discussion days we have emphasized that the key to a growing healthy, nutrient rich food was in the enhancement of organic matter and stimulation of soil biological activity. It has also been discussed that there may be a need for inorganic elements to top up what might have been removed from the soils through millions of years of rock weathering and removal of produce from the farm. Inputs of course are strictly regulated through organic standards.

Baw Baw Organics- Piedmont

The property is situated on the Noojee - Powelltown Road. The soils are derived from Tertiary volcanics 20-40 million years old. Given its fertility this soil is probably closer to 20 million years old so has not perhaps undergone as extensive weathering as some volcanic soils.

The Trial

In organic agriculture a green manure crop is usually used as two main management strategies. Firstly as a tool to rebuilding soil fertility, particularly soil organic matter and structure where the green manure crop is grown to a more mature stage with higher carbon/cellulose, and secondly as a fertilising element where the green manure is incorporated into the soil at a relatively young stage where on decomposition it provides a rich source of plant nutrients as it decomposes. Green manures can provide feed for livestock as well as an insectary for attracting beneficial insects.

Given that a major management strategy on arable organic farms is a rotation including green manure and legume crops it was discussed that a trial comparing a range of annual and biennial green manure legume and grass crops (ryecorn) would provide very useful information for growers.

The green manure crops were planted on the 28/5/15 & were incorporated in the soil on 7/10/15.

The trial plots were allocated as follows:

Plot 7 Lucerne
Plot 6 Rye corn
Plot 5 Legumes bi-annual
Plot 4 Legumes, annual
Plot 3 Rye corn, field peas, vetch
Plot 2 Oats, field peas, vetch
Plot 1 Control
Dairy North ⇧

What data was collected?

An initial full soil analysis was undertaken as a benchmark along with physical and biological assessments.

Each month a soil sample from all plots is taken and analysed for nitrate nitrogen, ammonium nitrogen, potassium and phosphorus. Along with this data, temperature and moisture readings are taken each month.

It is hoped that the analytical data would demonstrate the best option in terms of what green manure crops to use, & also to evaluate how biological activity might be affected by temperature changes and its impact on nutrient availability. Previous monitoring along similar lines on the Morris farm has indicated the dynamics of soil ecological systems with changes in temperature and moisture.

As for many of our field trials we have used Solvita soil tests to monitor soil respiration.

More recently we trialled a simple biological indicator test (incorporating 50mm square filter paper in onion bags) into each plot to study the decomposition rate.

Labile carbon, (the more easily degradable portion of organic matter) has been tested at the commencement and will be again tested at the conclusion of the study. It is well known that in arable horticulture/agriculture the loss of organic matter through cultivation is a common occurrence. The labile carbon will be measured at the end of the trial to enable an assessment of any organic matter loss/gain.

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Benchmark Soil Assessment

Physical attributes

- The red-brown volcanic soil is a well-structured soil with good worm populations and high organic matter. Water infiltration is good.

Benchmark soil analysis

- pH at 5.9 heading in the right direction. Not a problem in regard to availability of other elements given that organic matter at 9% is high and offers a substantial buffer.
- Olsen P (30ppm) available P is at a good level (>27ppm) no response from further additions)
- Both Colwell (75ppm) (>74ppm no response from further additions) and Bray2 P extractions are strong extractants taking P from more difficult to access P pools. The good available P levels indicate cycling of organic P which is what an organic farmer likes to hear.
- Total nitrogen at .37% is at a good level (Australian background <.2%) and nitrate nitrogen at 15.7 is excellent given that soil temperatures now are impacting negatively on nutrient cycling.
- For interest the Solvita soil health test (measuring CO_2 respiration) indicated a 5 where the scale reads from 1-5, so that is a good indication of an active biological soil.
- Calcium, magnesium and potassium levels are good (clay loam), and they are supplying the Base Exchange colloids with adequate amounts of nutrients. Base Exchange nutrients add up to about 96% (the balance being hydrogen and aluminium) illustrating why pH is just below optimum. These levels do suggest caution when applying a commercial mix that Mg and K are not too high in the formulation.
- Cation exchange 14%, (the storage house of these nutrients – clays and humus) is at a good level.
- Solvita soil health - All strips registered a 5 on a scale from 1-5 as a measure of biological health.
- Although most trace elements indicate they are below the desirable level observations by the producer of plant health and productivity would be a good guide as to whether there may be a problem. For example manganese is involved in chlorophyll synthesis so a yellowing of leaves during the growing season may not be a nitrogen deficiency but perhaps a manganese one. Given that availability of elements are now going to be affected by lower biological activity it is difficult to get too hung up about the levels. Trace amounts of these elements will also be applied during the incorporation of your standard commercial mix and compost. As we have seen in tissue analysis, lower soil levels are not always reflected in tissue samples.

Labile carbon across the strips are indicated below:

Plot 7 Lucerne	0.97%
Plot 6 Rye corn	0.95%
Plot 5 Legumes bi-annual	0.83%
Plot 4 Legumes, annual	0.91%
Plot 3 Rye corn, field peas, vetch	0.90%
Plot 2 Oats, field peas, vetch	0.84%
Plot 1 Control	0.80%
Dairy North ⇧	

Soil fertility summary

To the organic farmer although chemistry is important to ensure an adequate amount of nutrients are available for plant nutrition, a strong emphasis is placed on biological activity and the cycling of nutrients. Current management practices with the use of legumes and green manure crops in the rotation are ensuring that the soil fertility is maintained at a high level. Soil parameters noted at the benchmark stage of the project indicate a well-balanced, biologically active soil.

The analysis of the commercial fertiliser (Terra Firma) was as follows:

Nitrogen 3% Phosphorus 3% Potassium 3%

The analysis of the Lucerne (Plot 7) was as follows

Nitrogen 2.03% Phosphorus 0.23% Potassium 0.90% Calcium 1.81%

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What does the soil analysis mean in terms of nutrient availability?

Let's look at Nitrogen levels at end of January

Five of the plots have levels of nitrate nitrogen greater than 125ppm (ppm = mg/kg)

This equates to 223kg of available N to a depth of 150mm over 1 hectare (Calculated on soil volume in 1 ha and soil bulk density). Theoretically roots to a depth of 150mm have access to 223kg of nitrogen.

Through nutrient management the analysis indicates that the soils are generating sufficient nitrogen at this point in time to grow crop of both vegetables. This of course is only looking at the nitrate nitrogen levels. There are a number of other plant nutrients that would need to be considered based on the soil analysis.

It does indicate however how targeted a producer can be in terms of growing a particular crop based on its nitrogen needs.

Vegetables	Crop Removal Kg/N/ha
Carrots	86
Cauliflower	109
Celery	151
Lettuce	120
Onions	147
Potatoes	184
Tomatoes	148
Corn	310

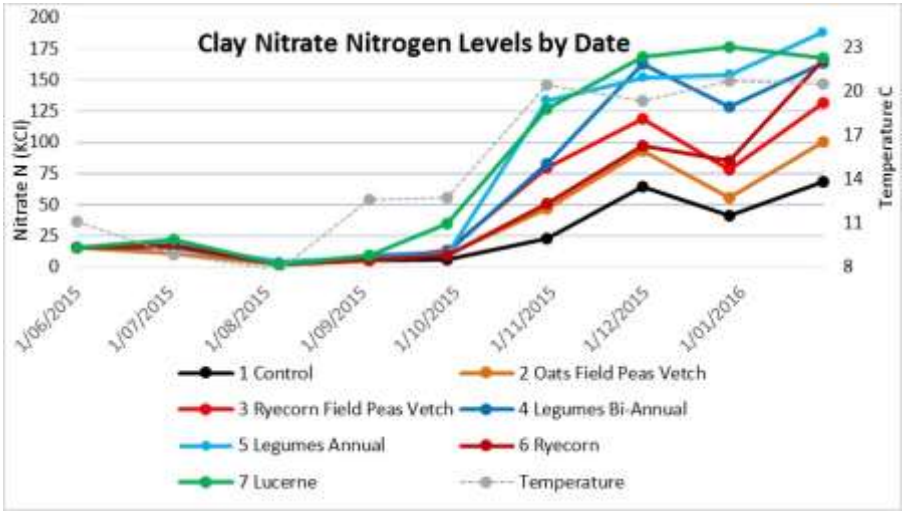
Results to date

Nitrate

The graph illustrate that nitrate nitrogen (available nitrogen) started increasing from the start of October when soil temperatures moved from about 15c to about 21c. Nutrient cycling microorganisms optimise their function between 20-30 degrees. The highest level is demonstrated in the beds with the lucerne.

Sufficient nitrogen is being mobilised in the system for all crops without additional supplementation. Only adverse soil conditions such as moisture deficiency would limit the nitrogen supply.

Nitrification of ammonium (NH_4^{+}) to nitrate (NO_3^{-}) preferably occurs under the following conditions:



- In the presence of nitrifying bacteria.
- Soil temperature > 20 °C.
- Soil pH 5,5 - 7,5.
- Sufficiently available soil moisture and oxygen.

		28/05/2015	1/06/2015	2/07/2015	5/08/2015	3/09/2015	28/09/2015	7/10/2015	30/10/2015	30/11/2015	28/12/2015	27/01/2016
Nitrate N (KCl)	Control	Green Manure Crop Sown	16	17	2	5	6	Green Manure Crop incorporated	23	65	41	69
	Oats, F Peas, Vetch		16	11	2	5	10		47	93	56	100
	R/corn, F Peas, Vetch		16	18	2	6	13		80	119	78	132
	Legumes (Bi-annual)		16	16	2	9	11		83	163	128	163
	Legumes (Annual)		16	18	4	8	10		134	152	154	188
	Ryecorn		16	17	2	6	9		51	97	85	166
	Lucerne		16	22	2	10	35		127	169	176	167
Soil temp C	Ave of all rows		11	9	8	13	13		20	19	21	21

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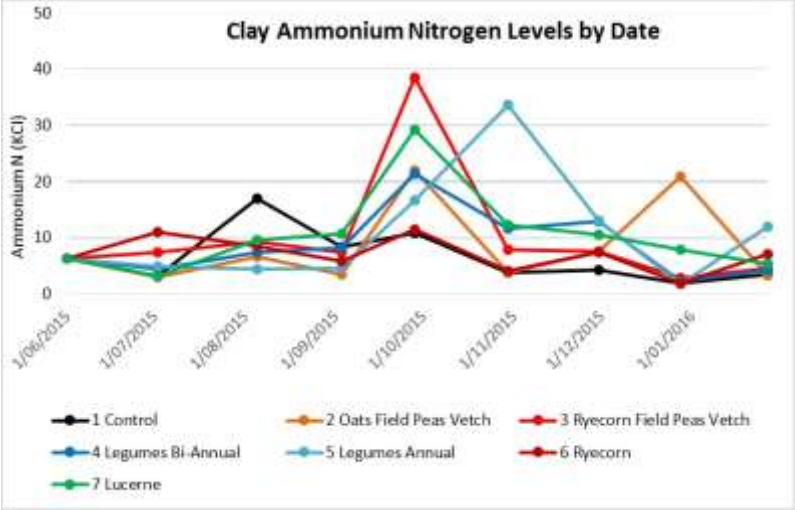
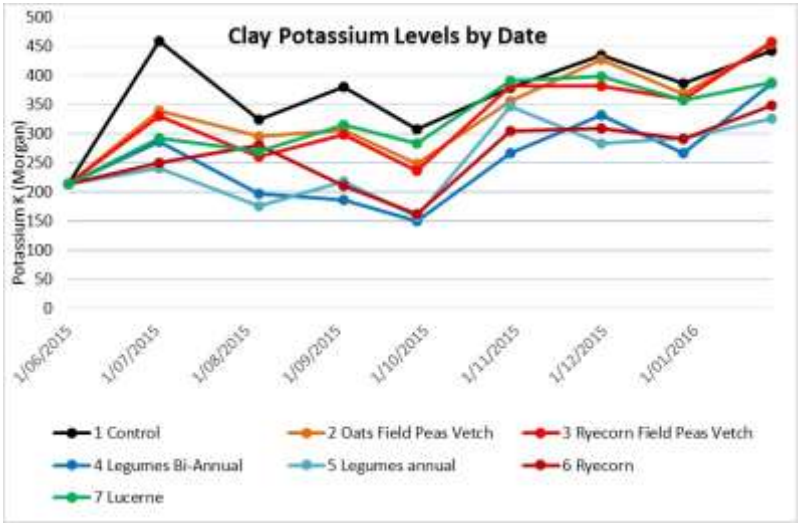
Ammonium nitrogen

Ammonium nitrogen is a transitional stage of the biological cycle where organisms convert organic matter/fertilisers into ammonium nitrogen. This phase is temporary as again microorganisms convert this ammonium nitrogen rapidly into available nitrate, which is easily accessed by plant roots.
It can be seen that through September ammonium production is occurring across the beds. Nutrient cycling is happening. Soil temperature at this stage ranges between 12 degrees C and 15 degrees C .



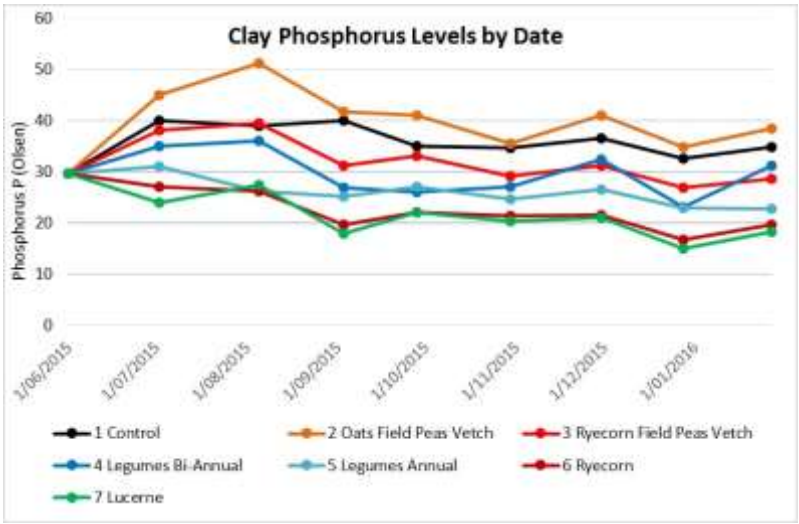
Potassium

The levels rise slightly as soil temperature and microbial activity increases although the control strip indicates higher levels of potassium at almost all sampling times. The control strip is at the top of the slope, is there an explanation here?



Phosphorus

Phosphorus levels are reasonably steady throughout the trial period. The extraction method used is Olsen P which extracts reasonably available phosphorus from the varios phosphorus pools like organic matter and soil solution. There was some thought that with increased soil temperatures phosphorus solubilising microorganisms may have demonstrated increasing levels of this element but this does not appear to be evident.



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Demonstrating Sustainable FARM PRACTICES

Litter bag decomposition

Litter bags with a 50mm piece of paper (cellulose) was placed in the soil of the strips to observe decomposition rates seen with the various green manure crops. The bags were placed in the soil in 30/10/15 and removed 28/12/15. It appears that the lucerne strip had more active cycling taking place followed by the control strip

Observations of vegetable growth (28/12/15)

Ryecorn and ryecorn mix showing larger bean plants. Beetroot, larger seen plants in the ryecorn strips. Beetroot smaller in lucerne plots and the control plots. Bean yields demonstrate the highest from the oats and legume strip (1.822kgs), ryecorn (1.550kgs) and the lucerne (1.290kgs). The legumes were the lightest yield of all the strips. The control yielded 1.448kgs not far behind the highest yields perhaps indicating the general high fertility of these soils.

Costs

	$kg	Sowing Rate kg/Ha
Oats	$1.65	60-80kg
Field Peas	$1.54	50-100kg
Ryecorn	$1.10	20-40kg
Vetch	$3.30	20-30kg
Lucerne	$12.60	10-20kg
Terra Firma	$1040t	2t

References

Green Manures-HDRA

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2. Data accessed from Fact Sheet, Understanding Nitrogen fertilisers for vegetable production on sands. http://www.perthregionnrm.com/media/83519/vegetables-perth-nrm-factsheet-4_lr.pdf
3. http://www.dpi.nsw.gov.au/agriculture/horticulture/vegetables/commodity/sweet-corn

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